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Open computer aided innovation to promote innovation in process engineering

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ABSTRACT

Recent advances in theoretical approaches to innovation and in information and communication technologies provide a more structured knowledge-driven environment for inventors, designers and engineers. Consequently, a new category of tools known as computer aided innovation (CAI) has emerged, with goals of assisting designers in their creative performance and of effectively implementing a complete innovation process throughout the entire product or process life cycle. Based on the concept of Open CAI 2.0 introduced by Hüsig and Kohn (2011), this paper goes further by proposing a prototype software tool for the next evolutionary step of CAI arising from two major recent developments: new advances in technological possibilities in the software field commonly referred to as "Web 2.0" and a strategic paradigm shift from closed to open innovation in many companies. This contribution is one of the first attempts to create a concrete methodological framework based on collective intelligence (through Web 2.0 practices), a collaboration support (with the benefits of on-line social networks) and a problem resolution process. In the proposed Open CAI 2.0, the inventive problem solving method is inspired by the coupling between the innovation theory TRIZ and case based reasoning in order to support the generation of inventive technological solutions because problem solving often requires a reformulation of the initial problem to construct an abstract model of the problem. This paper highlights the importance of knowledge acquisition, capitalization and reuse as well as the problem formulation and resolution in collaboration. A case study on biomass gasification is used to illustrate the method and tool capabilities in the chemical process industry.

1. Introduction

Within the industrial context, innovation is one of the key survival factors for firms. In parallel, the development of new products or processes is faced with major challenges due to the increasing complexity of new technologies, the rapid adaptation to market requirements, the tendency to reduce the life cycle and the need to reduce the time-to-market. To overcome these challenges, firms are in a transition in terms of how they drive the innovation process; they are evolving from a closed model to a more open approach that includes actors and knowledge beyond the enterprise. This evolution requires new methods and tools adapted to this new approach to manage the innovation process and the new knowledge created. The use of computer-aided technologies and, more specifically, computer aided innovation (CAI) is part of the strategy to facilitate this transition (Hüsig and Kohn, 2009).

In the array of computer-aided tools, the initial studies on CAI aimed to assist process engineers during the creative stage of the design process, also called the fuzzy front end.

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Subsequently, the scope was extended such that the goal of CAI systems is to effectively support the entire innovation process, from the fuzzy front end with the generation of ideas, through detailed design and development, up to the withdrawal or recycling. Recent advances in information and communication technologies and in theoretical approaches to innovation provide a new environment for the next evolutionary step of the CAI to enable users to rapidly reach better solutions to inventive problems and improve cost efficiency. The main contribution of this article is to include both advances in current CAI and to propose the next evolution stage of this type of computer-aided tool, referred as Open CAI 2.0 (concept introduced by Hüsig and Kohn (2011)). However, prior to detailing the proposed method and tool to fill the gap between CAI and Open CAI 2.0, the remainder of this section is primarily focused on the state-of-the-art in CAI in general and in their implementation in process engineering in particular.

1.1. CAI classification

CAI systems can range from simple applications for specific activities of the innovation process to systems that support the entire innovation process. Consequently, the CAI field requires a comprehensive classification of the different types of existing systems to clarify the scopes of these tools. To better understand the term CAI, Hüsig and Kohn (2009) have categorized the existing software into the following three categories:

- Strategy management: helps innovation managers to address strategic issues such as portfolio or scenario management.
- Idea management: helps to address the fuzzy front end of innovation process, from idea generation to idea evaluation.
- Patent management: these types of tools are used both to protect inventions and to search and analyse patents as an approach to stimulate creativity.

In some cases, an application might cover the aspects of more than one category. In addition to providing a comprehensive overview of CAI systems, each category of this initial classification can be further divided into subcategories, as shown in Fig. 1. For example, in the idea management category, idea generation refers to tools that implement creative techniques, and idea collection encompasses knowledge-based systems to enhance collection and reuse of knowledge. Because CAI systems are constantly evolving, this framework must be improved to integrate recent developments, for example, all the community aspects linked to open innovation might be considered (Section 2.1).

1.2. CAI benefits

In many industries and institutions, the growing trend towards CAI systems would not be possible, unless significant advantages were to be expected from their use. Hüsig and Kohn (2009) have introduced a classification of the potential benefits of innovation software: efficiency, effectiveness, competence and creativity. However, the principal benefits that can arise from CAI systems are linked to expected gains in productivity, speed, reducing costs and stimulating internal innovation. In summary, some of the most significant potential benefits of implementing CAIs are as follows:

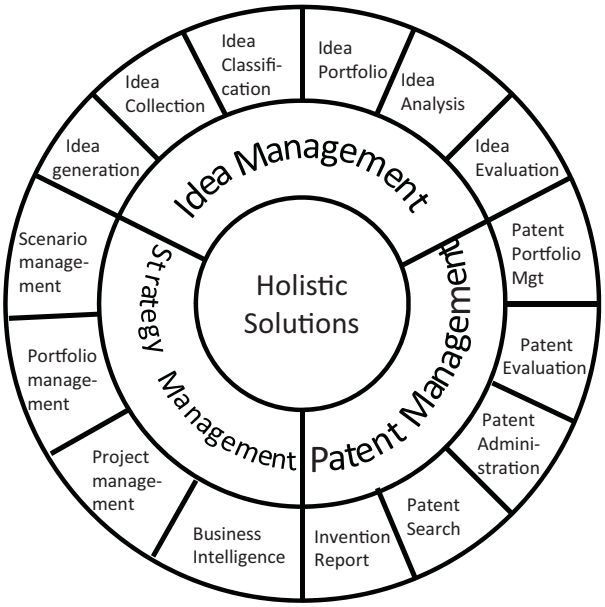

Fig. 1 – Detail CAI software categories (Hüsig and Kohn, 2009).

- More efficient innovation processes thanks to new methods to enhance the storage and reuse of the relevant knowledge; this is improved with advancements in current information and communication technologies (ICT).
- Dedicated tools to support innovation process rather than standard IT-software such as spreadsheet calculation programs.
- Acquisition and knowledge management required for product/process development. This enhances the competence of the system with less effort because knowledge is rapidly updated and its transfer is permanent to provide the new advances.
- Collaborative work within the innovation process, which is a primordial aspect during idea management, from idea generation to idea selection.
- Simplified use of creativity techniques (key innovation success) to generate inventive insights, e.g., TRIZ (Russian acronym for Theory of Inventive Problem Solving). Moreover, software has a positive effect on group productivity and on the novelty of the idea generated because knowledge management helps to stimulate creativity.
- Access to databases and to patent analyses. The goal of patent analyses is to reduce the number of patents to browse to extract the most relevant patents, to identify the knowledge to transfer between technical domains, to aid in idea generation and to translate the description of an invention into a conceptual functional map (Leon, 2009).

1.3. CAI in chemical process engineering

In chemical engineering design, computer-aided software tools are used in a wide range of applications for modelling and optimization to design or simulate the performances of processes or products. CAI software tools are more focused on the creative stage to improve the performance of the generated concepts. These tools allow the number of creative solutions to be increased and the different alternatives to be explored more thoroughly. Because the majority of CAI software tools are knowledge-based systems, solutions with important novelty can be suggested based on different ideas.